
U.S. DEPARTMENT OF AGRICULTURE • LIBRARY •

TWENTY-FIRST ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE.

1905.

AUGUSTA
KENNEBEC JOURNAL PRINT
1906

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

THE STATION COUNCIL.

President George E. Fellows	*President*
Director Charles D. Woods	*Secretary*
John A. Roberts, Norway	*Committee of Board of Trustees*
Charles L. Jones, Corinna	*Committee of Board of Trustees*
Albert J. Durgin, Orono	*Committee of Board of Trustees*
Augustus W. Gilman, Foxcroft	*Commissioner of Agriculture*
Eugene H. Libby, Auburn	*State Grange*
Charles S. Pope, Manchester	*State Pomological Society*
Rutillus Alden, Winthrop	*State Dairymen's Association*
James M. Bartlett	*Members of the Station Staff*
Lucius H. Merrill	*Members of the Station Staff*
Fremont L. Russell	*Members of the Station Staff*
Welton M. Munson	*Members of the Station Staff*
Gilbert M. Gowell	*Members of the Station Staff*
Edith M. Patch	*Members of the Station Staff*

THE STATION STAFF.

Charles D. Woods	*Director*
James M. Bartlett	*Chemists*
Lucius H. Merrill	*Chemists*
Herman H. Hanson	*Chemists*
*Sanford C. Dinsmore	*Chemists*
†Lewis I. Nurenberg	*Chemists*
Fremont L. Russell	*Veterinarian*
Welton M. Munson	*Horticulturist*
Gilbert M. Gowell	*Poultry Investigations*
Walter Anderson	*Poultry Investigations*
Edith M. Patch	*Entomologist*
‡Bessie G. Tower	*Microscopist and Photographer*
Annie M. Snow	*Clerk and Stenographer*
Henry A. Millett	*Meteorological Observer and Janitor*

---

*Resigned June 30, 1905.

†Appointed October 20, 1905.

‡Appointed September 1, 1905.

TABLE OF CONTENTS.

The Bulletins of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,
Orono, Maine.

ANNOUNCEMENTS.

THE AIM OF THE STATION.

Every citizen of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glass-ware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published, if they prove of general interest.

INSPECTIONS.

The execution of the laws regulating the sale of food, commercial fertilizers, concentrated commercial feeding stuffs, and agricultural seeds, and the inspection of chemical glassware used by creameries is entrusted to the Director of the Station. The Station takes pains to obtain for analysis samples of all brands of fertilizers and feeding stuffs coming under the law. It also draws samples of agricultural seeds and foods in the hands of dealers. The co-operation of dealers and consumers is, however, essential for the full and timely protection of their interests.

Foods. Dealers and consumers are invited to send by prepaid express original and unbroken packages of food materials on sale in Maine of whose purity they are for any reasons sus-

picious. As prompt free analysis will be made of such samples as circumstances will allow.

Feeding Stuffs. The Station will promptly analyze samples of feeding stuffs sold in Maine taken in accordance with directions which will be furnished on application. The results will be reported without charge to interested parties. This applies to dealers and consumers alike.

Commercial Fertilizers. It is difficult to draw accurate samples of commercial fertilizers. On this account it is only in rare instances that the Station undertakes analyses of fertilizers other than the samples collected by its representatives. In case there is special reason for an examination, the Station invites correspondence on the subject.

Agricultural Seeds. Samples of agricultural seeds on sale in Maine, taken in accordance with directions which can be obtained on application to the Station, will be examined as promptly as possible and the results reported free of charge.

In all cases samples should be accompanied by a full description of the goods, including the name and address of the dealer and the sender. Small samples other than liquids can be forwarded by mail. Others should be forwarded by express, charges prepaid.

STATION PUBLICATIONS.

The Station publishes several bulletins each year, covering in detail its expenses, operations, investigations and results. The bulletins are mailed free to all citizens who request them. The annual report is made up of the bulletins issued during the year.

CORRESPONDENCE.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications should, therefore, be addressed to the

Agricultural Experiment Station,
Orono, Maine.

The post office, railroad station, freight, express and telegraph address is Orono, Maine. Visitors to the Station can take the electric cars at Bangor and Old Town.

The Station is connected by telephone.

HISTORICAL NOTES FOR 1905.

FOOD AND SEED LEGISLATION.

The legislature of 1905 passed a pure food law and supplemented the law regulating the sale of agricultural seeds. The director of the Station is the executive officer of both of these controls. The details of the food legislation is given on pages 77 and following of this report. A bulletin on seed inspection is in preparation and will be published early in 1906.

CHANGES OF STAFF.

Mr. S. C. Dinsmore resigned as assistant chemist in June, 1905, to accept an appointment with the Nevada Experiment Station. Mr. Lewis I. Nurenburg, B. S., Harvard, 1905, has been appointed in his place. Miss Bessie G. Leeds, B. A., University of Minnesota, 1905, was appointed September 1 as a general assistant. Miss Leeds will do the photographic work of the Station and will assist in the analyses of foods and seeds.

THE INCUBATOR HOUSE.

The Station, as described on pages 105 and following of this report, is unusually well equipped along the lines of poultry investigation, with the exception that the rooms used for incubation work were unsatisfactory. An incubator house 31 x 31 feet, was erected in the fall of 1905. The building is one story in height with a good attic, and airy basement. The basement is used for the incubators and is supplied with 18 machines having a capacity of 6480 eggs. Two flues provide ample ventilation. The remainder of the building is finished as a tenement for the poultry man.

LIST OF BULLETINS PUBLISHED IN 1905.

---

112. Potato Experiments in 1904.
113. Practical Horticulture. Red Clover.
114. Fertilizer Inspection.
115. Feeding Stuffs Inspection.
116. Food Inspection. Law and Standards.
117. Poultry Experiments.
118. Cereal Foods.
119. Food Inspection. Vinegar, Baking Powder.
120. Fertilizer Inspection.
121. Cottony Grass Scale.
122. Orchard Experiments.
123. Insect Notes for 1905.
124. Finances, Meteorology, Index.

Maine Agricultural Experiment Station

BULLETIN No. 112. JANUARY, 1905.

POTATO EXPERIMENTS IN 1904.

This bulletin contains an account of storage experiments upon the rotting of potatoes due to late blight; experiments with dry Bordeaux mixture and soluble Bordeaux mixture as a preventive of blight; and experiments with home mixed fertilizers for potatoes.

Requests for bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
Orono, Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION,
ORONO, MAINE.

THE STATION COUNCIL.

PRESIDENT GEORGE E. FELLOWS	*President*
DIRECTOR CHARLES D. WOODS	*Secretary*
JOHN A. ROBERTS, Norway	*Committee of Board of Trustees*
CHARLES L. JONES, Corinna	*Committee of Board of Trustees*
ALBERT J. DURGIN, Orono	*Committee of Board of Trustees*
AUGUSTUS W. GILMAN, Foxcroft	*Commissioner of Agriculture*
EUGENE H. LIBBY, Auburn	*State Grange*
CHARLES S. POPE, Manchester	*State Pomological Society*
RUTILLUS ALDEN, Winthrop	*State Dairymen's Association*
JAMES M. BARTLETT	*Members of the Station Staff*
LUCIUS H. MERRILL	*Members of the Station Staff*
FREMONT L. RUSSELL	*Members of the Station Staff*
WELTON M. MUNSON	*Members of the Station Staff*
GILBERT M. GOWELL	*Members of the Station Staff*

THE STATION STAFF.

THE PRESIDENT OF THE UNIVERSITY.

CHARLES D. WOODS	*Director*
JAMES M. BARTLETT	*Chemist*
LUCIUS H. MERRILL	*Chemist*
FREMONT L. RUSSELL	*Veterinarian*
WELTON M. MUNSON	*Horticulturist*
GILBERT M. GOWELL	*Stock Breeding and Poultry*
EDITH M. PATCH	*Entomologist*
HERMAN H. HANSON	*Assistant Chemist*
SANFORD C. DINSMORE	*Assistant Chemist*

NOTES ON THE ROTTING OF POTATOES DUE TO THE LATE BLIGHT FUNGUS.

(*Phytophthora infestans.*)

CHAS. D. WOODS.

During the past few years, in connection with experiments at this Station, considerable data have accumulated on the rotting of potatoes due to the fungus that produces the late blight. Such as are believed to be of general interest are here reported.

ROTTING IN THE CELLAR DUE TO PREVIOUS INFECTION.

In 1902 a three-acre field of Green Mountain potatoes, which had been sprayed several times during the growing season and which had been kept practically free from the late blight, was harvested before the tops were dead, and stored in one bin in a cool cellar. The day of digging was warm and rather muggy. The tubers were fairly well dried off, however, before being put in the cellar. The following days were unusually warm for the season. At harvest there was very little evidence of rot. Perhaps there was one bushel of discolored potatoes in 100, but no really rotten potatoes were found. Early in November it was noticed the potatoes were rotting badly. They were carefully assorted and it was found that fully one-third of the crop was more or less affected with rot due to late blight.

As there were so few affected potatoes at harvest, and so much rot had developed in a few weeks, it was thought possible that the sound potatoes were infested after digging. To test this, two barrels of sound potatoes were selected at the time of assorting in November, and to each peck of sound tubers two potatoes showing unquestionable signs of incipient rot were added. To learn if the treatment of the tubers with different substances would tend to decrease the amount of infection, five lots of two barrels each of selected tubers were treated with (1) flowers of sulphur, (2) copper sulphate, (3) air slacked lime,

(4) Bordeaux mixture, and (5) a 3 per cent solution of formaldehyde. The 12 barrels were kept in the cellar until April. There was very little further rot in either the untreated or the treated barrels of potatoes. On the whole, about 90 per cent of the tubers were still perfectly sound and free from discoloration.

This seemed to justify the conclusion, which other tests have confirmed, that the danger of the transmission of rot due to the fungus which produces the late blight from one affected potato to another is remote. In this, as in other instances, the rot undoubtedly resulted from infection in the field. As the tops were kept green by the application of Bordeaux mixture and there were so little signs of the presence of the blight, the infection could hardly have been through the vines. The field was heavily dressed with stable manure only a short time before planting. There is little doubt that the fungus was carried to the field in the manure and that the tubers were directly infected, while the tops escaped the attack. This is in accord with the common experience so often noted before the use of Bordeaux mixture, that potatoes were more subject to blight and subsequent rot when grown on manure than on chemicals, or without the application of fertilizer of any kind. From the results of the experiments that follow, it is doubtful if there would have been anything like this loss from rot in the cellar, if the potatoes had been allowed to remain a few days in the ground after the tops had ripened, or after they had been killed by frost.

EFFECT OF TIME OF DIGGING UPON SUBSEQUENT DEVELOPMENT OF ROT.

In 1903 a variety test was conducted to study the differences in a few varieties in their abilities to resist blight. These results were given in detail in Bulletin 98 of this Station. Advantage was taken of this experiment to study the keeping qualities of the potatoes, comparing different varieties, sprayed with unsprayed, and early with late dug potatoes. At the distance these potatoes were planted and with a uniform stand, fifty-five hills almost exactly represents 1-300 acre. The yields at the time of digging are given in the following table.

Yields from fifty-five hills of ten varieties potatoes at time of digging.

Variety.	Date of harvesting.	Unsprayed.			Sprayed.		
		Good—lbs.	Rotten—lbs.*	Small—lbs.	Good—lbs.	Rotten—lbs.*	Small—lbs.
Early Michigan	Sept. 8	55	19	4	78	3	7
	Oct. 7	52	21	7	78	1	7
Average		54	20	6	78	2	7
Bovee	Sept. 8	45	33	6	60	12	8
	Oct. 7	59	28	5	57	11	7
Average		52	31	6	59	12	.....
Early Ohio	Sept. 8	18	40	5	49	22	6
	Oct. 7	32	38	3	68	16	8
Average		25	39	4	59	19	7
Gem of Aroostook	Sept. 8	46	24	5	71	20	9
	Oct. 7	74	36	5	72	13	5
Average		60	30	5	72	17	7
Irish Cobbler	Sept. 8	95	20	9	111	12	5
	Oct. 7	66	13	7	107	6	6
Average		81	17	8	109	9	6
Hulett's Rust Proof	Sept. 8	.....	.....	.....	.....	.....	.....
	Oct. 7	81	1	7	99	.....	6
Mill's Mortgage Lifter	Sept. 8	68	24	4	.....	.....	.....
	Oct. 7	82	25	5	82	.....	3
Average		75	25	5	82	.....	3
Green Mountain	Sept. 8	68	37	4	.....	.....	.....
	Oct. 7	84	18	5	153	11	4
Average		76	28	5	.....	.....	.....
Polaris	Sept. 8	63	40	5	.....	.....	.....
	Oct. 7	59	41	6	105	20	7
Average		61	41	5	.....	.....	.....
Maggie Murphy	Sept. 8	55	28	2	.....	.....	.....
	Oct. 7	51	52	2	87	14	2
Average		53	40	2	.....	.....	.....
Average of 5 earlier varieties	Sept. 8	52	27	5	74	13	7
	Oct. 7	57	27	5	76	10	7
Average of 5 later varieties	Sept. 8	54	27	5	75	11	7
	Oct. 7	71	27	5	104	9	6

*All discolored potatoes are here included.

The potatoes as soon as dug were put in bags, and stored in a cool cellar, so as to be kept dry and not subject to heat. The very last of December and early in January the potatoes were carefully assorted, and any potatoes that showed the slightest indications of even incipient decay, were rejected. In this, as in all such work by the Station, many potatoes were rejected that in ordinary sorting would be sent to market. The pounds of apparently sound potatoes that were put into the cellar at the date of harvest, the pounds of sound potatoes that were found

about January 1 when the potatoes were next examined, and the percentage of potatoes that had remained sound, are given in the table which follows.

Merchantable potatoes from fifty-five hills of nine varieties of potatoes at time of digging and after storing.

Variety.	Date of harvesting.	Weights and Per Cent Merchantable Potatoes.					
		Unsprayed.			Sprayed.		
		At harvest—lbs.	Jan. 1—lbs.	Per cent.	At harvest—lbs.	Jan. 1—lbs.	Per cent.
Early Michigan	Sept. 8	55	27	50	78	51	66
	Oct. 7	52	44	85	78	69	89
Bovee	Sept. 8	45	10	22	60	39	65
	Oct. 7	59	53	90	57	52	92
Early Ohio	Sept. 8	18	11	61	49	36	73
	Oct. 7	32	29	90	68	63	93
Gem of Aroostook	Sept. 8	46	10	22	71	26	54
	Oct. 7	74	58	78	72	55	76
Irish Cobbler*	Sept. 8	95	62	65	111	72	64
	Oct. 7	66	64	97	107	93	87
Mill's Mortgage Lifter	Sept. 8	68	49	72	.....	.....	.....
	Oct. 7	82	75	92	82	81	91
Green Mountain	Sept. 8	68	35	52	.....	.....	.....
	Oct. 7	84	80	95	153	130	85
Polaris	Sept. 8	63	33	52	.....	.....	.....
	Oct. 7	59	53	90	105	94	90
Maggie Murphy	Sept. 8	55	9	16	.....	.....	.....
	Oct. 7	51	44	86	87	75	86
Average of 4 early varieties	Sept. 8	41	15	39	74	45	64
	Oct. 7	54	46	86	76	66	87
Average of 4 later varieties	Sept. 8	64	32	48	75	.....	.....
	Oct. 7	69	63	91	104	95	90
Average of 8 varieties	Sept. 8	54	23	43	.....	.....	.....
	Oct. 7	62	55	88	.....	79	88

*Omitted from averages.

Experiments made at the Vermont Station* showed that in the case of potatoes dug every 12 days, August 25 to September 30 in 1902, and every 7 days, August 31 to September 28 in 1903, there was a much larger weight of potatoes still sound at the time of the later digging than from the earlier diggings. This is in accord with the experiments here reported, except that

*The relation of date of digging potatoes to the development of rot; L. R. Jones and W. J. Morse, Proceedings Society for Promotion of Agricultural Science, 1904

in the latter case the potatoes were subjected to the much severer test of three months storage.

CONCLUSIONS.

From experiments on the keeping of potatoes and upon the development of rot due to the late blight fungus, the following conclusions appear warranted:

The infection of the potatoes with the fungus occurs chiefly, if not entirely, in the field before digging.

The infection is usually the result of diseased vines.

The disease is transmitted, in the majority of cases, not directly through the vine, but indirectly through the soil.

Potatoes may be infected directly in the field from spores introduced in the manure, or from rotten potatoes spread upon or left in the land the preceding year.

Jones and Morse* conclude that the mycelium which produces the rot normally passes into a dormant stage after infesting the potato, but that abnormal conditions of moisture or temperature may cause abnormal activity in the fungus, and hence the rotting of the tubers.

Whatever may be the explanation, these experiments all agree in showing that, whether the vines have or have not been protected with Bordeaux mixture, there is far less liability of loss from rotting in the cellar in the case of late dug potatoes.

* Loc. cit.

EXPERIMENTS WITH DRY BORDEAUX.

CHAS. D. WOODS.

For a number of years dry Bordeaux has been upon the market. The best known is that made by Leggett and Brother, New York, and first sold under the trade name of fungiroid. This is made by using equal weights of lime and sulphate of copper. As used by us the past season, this dry Bordeaux carried practically the amount of copper claimed by the makers. It would therefore take 10 pounds of the dry Bordeaux mixture to furnish the same weight of copper as carried in 50 gallons of Bordeaux mixture prepared in accordance with the directions of this Station. Dry Bordeaux has been used successfully upon fruit trees, particularly in the middle west and southwest. Thus used it is greatly reduced with dry powdered lime. For potatoes the manufacturers recommend that it be reduced with one part of fine lime to 2 parts of dry Bordeaux. While it can be wet up and applied with a spray, it is designed to be used dry and applied with a powder gun.

In some localities it is a difficult problem to obtain the needed water for spraying and this, because of the labor involved, is, at times, the most expensive part of spraying. For this reason it was deemed of value to test dry Bordeaux applied as a dust against the ordinary Bordeaux mixture applied as a spray. Since it would be impracticable to use it on a large field while the foliage was still wet from dew, it was in this test applied in bright sun with the tops perfectly dry and even when the wind was quite strong. If it would not protect under these conditions, however valuable it might be for the garden where it can be applied on vines wet from dew or rain, it would be of no value for extended field use.

THE EXPERIMENT.

Two acres planted to Green Mountain potatoes, on the farm of John Watson, Houlton, were selected for the experiment. The field was planted about the twentieth of May and at the time it was selected there was a good even stand, and the field had

been sprayed once, on June 28, with Bordeaux mixture and Paris green. One acre was dusted with 8 pounds of dry Bordeaux mixture on the following dates: July 5, 13, 20 and 28; August 3, 10, 16, and 22. July 5 and 13, Paris green was used with the Bordeaux. At no time were there potato bugs of any amount on the vines, nor did the flea beetle do any appreciable damage. Late in August there were more plant lice than usual, but not enough to damage the vines at all seriously. During the growing season there was no appreciable difference in the appearance of the dusted from the sprayed, except the dusted were lighter in color and the vines were less broken in the latter part of the season by the man walking through than by the horses on the sprayer. The darker color of the sprayed acre was more conspicuous at a distance and was doubtless due to the adhering Bordeaux mixture. At digging, the vines were dead on both plots from frost. At no time was there blight of any amount upon either acre. The yields were as follows:

Yield of potatoes upon one acre sprayed with regular Bordeaux and a corresponding acre dusted with dry Bordeaux. The fungicides were applied nine times during the season.

	Large bbls.*	Small bbls.	Rotten bbls.†
Regular Bordeaux mixture.....	122	17	none
Dry Bordeaux mixture.....	114	17	5

From the above results it would seem that the dry Bordeaux applied to dry vines is not effective in preventing blight and subsequent rot. It will be tested another season on damp vines to see if it is of value as a fungicide in garden culture of potatoes.

A Kansas manufacturer of dusting apparatus claims that ready prepared Bordeaux mixture is inert and that satisfactory results can be obtained by dusting on a mixture of finely pulverized copper sulphate and lime. The claim is made that these materials react as soon as moistened by dew and that the Bordeaux mixture thus freshly formed is as effective as the regular Bordeaux mixture applied as a spray. This will also be tested another season.

* One barrel is 2¾ bushels or 165 pounds.

† All discolored potatoes are included under rotten.

SOLUBLE BORDEAUX FOR POTATO BLIGHT.

CHAS. D. WOODS.

In the preparation of Bordeaux mixture from slacked lime and sulphate of copper, a chemical change takes place whereby hydrate of copper and sulphate of lime (gypsum) are formed. Both of these materials are insoluble in water, and Bordeaux mixture consists of these materials mechanically suspended in water. The gypsum is so heavy that, unless the mixture is kept thoroughly stirred, it will speedily separate out and bring down with it the lighter hydrate of copper. This necessitates the use of an agitator, and much of the unsatisfactory work of the spray as applied by some of the outfits on the market is due to imperfect agitation. Commercial Bordeaux mixtures have been made in which part of the gypsum has been taken out. Such mixtures are more easily kept in suspension, but there has not been sufficient gain to compensate for the extra labor involved in the preparation of such Bordeaux mixtures. For many years it has been known that the addition of sugar would render the hydrate of copper soluble. If the sugar is added to the slacked lime and allowed to stand for some time before adding it to the sulphate of copper solution, hydrate of copper, soluble in water, with only a trace of gypsum results.

Obviously Bordeaux in solution would present many desirable features. The director of the Wisconsin Experiment Station wrote that they were to experiment during the season of 1904 with such a Bordeaux mixture and invited the co-operation of this Station to test its efficacy upon potatoes in order that data might accumulate faster. Some of the possible merits of this new Bordeaux mixture were pointed out as follows:

"It is believed, on account of the soluble condition of the copper hydrate in this preparation, that its efficiency as a fungicide will be much greater than in the ordinary Bordeaux mixture, and consequently that it may be diluted at least ten and

possibly fifty times and still protect plants from the ordinary fungus diseases. In addition to this advantage, the absence of solid particles permits the use of a much finer spray than is now employed, and it is evident that with a fine spray much more surface can be covered with the same amount of material. In these two ways it is hoped that the expense for the materials used in spraying may be greatly reduced."

The soluble Bordeaux used in the experiments here reported was prepared in accordance with the following directions furnished by Dr. S. M. Babcock, chemist to the Wisconsin Agricultural Experiment Station.

PREPARATION OF SOLUBLE BORDEAUX.

1. Copper sulphate solution—Dissolve 1 lb. of copper sulphate in 2 gallons of cold water. Will keep indefinitely.

2. Solution of sucrate of lime—Slake 10 lbs. fresh lime in 30 lbs. of water, strain the milk of lime through a wire strainer and add a solution of 25 lbs. of granulated sugar in 50 lbs. of water. Stir thoroughly at frequent intervals, and after two or three hours decant or siphon the clear liquid from the undissolved lime. The lime and sugar solution can be conveniently mixed in a revolving barrel churn.

The quantities named are sufficient for about 8 gallons of standard solution of sucrate of lime.

The solution will keep indefinitely if placed in well stoppered bottles, but if open to the air will gradually absorb carbonic acid gas and the lime will separate.

After siphoning off the clear solution, the residue still contains some sugar which may be recovered by adding considerable water and allowing the residue to settle a second time. The clear solution obtained may be used in place of an equal quantity of water in the preparation of the next lot.

SOLUBLE BORDEAUX.

Take equal parts of solution 1 and 2 and add three parts of water. Agitate until the copper hydrate which is at first precipitated is entirely dissolved. Upon standing, a slight deposit of

gypsum is formed, leaving a deep blue solution of hydrate of copper. If desired, the spray may be applied immediately after preparation, as the small amount of finely divided gypsum will not interfere. Prepared in this manner, the solution contains about the same amount of copper hydrate as the ordinary Bordeaux mixture. It may be diluted indefinitely with water without a precipitate forming. The solution should be kept in well stoppered bottles and is best if used within 48 hours after preparation.

In case complete solution of the copper hydrate is not obtained, add a little more of solution No. 2 of sucrate of lime. As prepared, the soluble Bordeaux is, because of the sugar, much more expensive than regular Bordeaux carrying the same amount of copper. In the experiments here reported the soluble Bordeaux carried about one-half, one-fourth and one-seventh as much copper as the usual mixture.

The field of potatoes selected for the experiment was upon the farm of Mr. Clarence A. Powers, Maple Grove. It was planted to Green Mountains, and the rows were of such length that 12 rows made about an acre. The rows ran east and west. The field was apparently quite uniform, and sloped slightly toward the south and east. The potatoes were liberally fertilized, and thoroughly cared for during the growing season. The soluble Bordeaux as well as the regular Bordeaux mixture was applied with a one-horse Getchell sprayer that was provided with a powerful pump and an agitator that kept the solutions thoroughly stirred. Vermorel nozzles were used, so that with the pressure obtained the materials were all applied in a fine spray.

The arrangement of plots and their treatment was as follows:

Plot A. Twelve rows (one acre) on south side of field, sprayed with regular Bordeaux mixture.

Plot B. Twelve rows (one acre) next north were treated with soluble Bordeaux at such a rate that the copper applied at each application was equivalent to about 2⅔ pounds of sulphate of copper to the acre.

Plot C. Twelve rows (one acre) next north were treated with soluble Bordeaux equivalent to 1⅓ pounds of sulphate of copper each application.

Plot D. Twelve rows (one acre) next north were treated with soluble Bordeaux equivalent to ⅔ pounds of sulphate of copper per acre each application.

Plot E. Twelve rows (one acre) next north were sprayed with the regular Bordeaux mixture.

DATES OF SPRAYING AND NOTES.

July 8. (The soluble Bordeaux experiment had not at this time been planned.) The whole field was sprayed with regular Bordeaux mixture. The plants were in early bloom.

July 15. Plots A and E sprayed with 2-3 pound Paris green and 3 pounds lime. Plots B, C and D sprayed in both directions with soluble Bordeaux and 2-3 pound Paris green.

July 22. Plots A and E sprayed in both directions with regular Bordeaux mixture and 2-3 pound Paris green per acre. Other plots sprayed as the 15th.

July 27. All plots sprayed on the 22d, except that no Paris green was used.

July 29. All plots in fine shape. No signs of disease.

August 5. Potatoes in full bloom. No signs of blight. Very few rumors of any blight in the county.

August 10. All plots sprayed as before, but without Paris green.

August 13. Quite a few plant lice on some plants on all the plots.

August 20. Possibly a little blight on soluble Bordeaux plots. Plant lice are doing some damage.

September 1. Quite a heavy frost. But little damage on this field.

As will be observed from the notes, this field was sprayed only 4 times, or about half the number that is desirable. As it proved in this particular year, it was apparently sufficient to keep off blight and rot. At digging there was no sign of rot upon the potatoes from the plots treated with regular Bordeaux mixture.

YIELDS.

Through a misunderstanding, the potatoes on plot E were dug in the absence of a Station representative, and while the yield was taken, it is so much larger than that on the other plots that it may have been an error. There were so few small potatoes and practically no rotten ones that no separation was made in the field.

Yield plot A, regular Bordeaux, 103 barrels.

Yield plot B, soluble Bordeaux 2⅔ pounds copper sulphate, 102 barrels.

Yield plot C, soluble Bordeaux 1⅓ pounds copper sulphate, 97 barrels.

Yield plot D, soluble Bordeaux ⅔ pound copper sulphate, 91 barrels.

Yield plot E, regular Bordeaux, 120 barrels.*

The potatoes on plot D were smaller than on the other plots and the skins of many of them darkened somewhat, resembling rot. Still, only a very few were rotten.

The experiments at the Wisconsin Station, through unavoidable complications, were a failure. In experiments upon potatoes made at the New York (Geneva) Experiment Station in 1903 the yields per acre were as follows: Unsprayed, 107 bushels per acre; soluble Bordeaux, 118 bushels per acre; soda Bordeaux mixture, 160 bushels per acre; regular Bordeaux mixture, 175 bushels per acre.

CONCLUSIONS.

The soluble Bordeaux of equal strength to regular Bordeaux mixture costs much more, both in materials and labor, than regular Bordeaux mixture. The yields were smaller and the quality inferior from the plots sprayed with soluble Bordeaux. For both of these reasons its use is not recommended.

* Yield not taken by a station officer.

EXPERIMENTS WITH POTATOES ON HOME MIXED FERTILIZERS.

CHAS. D. WOODS.

In answer to numerous inquiries for a formula for potatoes in which tankage could be used, the following newspaper bulletin was sent out and generally printed in the papers of the State in the early spring.

A crop of 300 bushels of potatoes removes from the soil about 55 pounds nitrogen, 25 pounds phosphoric acid and 85 pounds potash. A formula on this basis would carry five parts nitrogen, two parts phosphoric acid, and eight parts potash.

In preparing a field for a crop, the needs of the soil to render it fertile are, however, of greater moment than the special needs of a particular crop. The results of numerous field experiments indicate that the potato does best in a soil abundantly supplied with all fertilizing elements.

If a farmer has not experimented with his soil so as to know to what fertilizing elements it most readily and profitably responds, he must use a formula, and one carrying about 3 to 3½ per cent nitrogen, 5 to 6 per cent available phosphoric acid, and 4 to 5 per cent potash will usually be found as profitable as any. Bearing in mind that there is no such thing as a "best" fertilizer and that different conditions make different demands, some such formula as the following can be satisfactorily used per acre until, by experimental knowledge of his own soil requirements, the individual farmer has learned a better one.

One hundred pounds nitrate of soda, 200 pounds cottonseed meal, 500 pounds fine bone tankage, 400 pounds acid phosphate, and 200 pounds muriate, or perhaps better, sulphate, of potash. These goods are very concentrated and would probably be more evenly applied if mixed with 500 pounds dry loam, muck, or some similar fine material. This weight of materials would carry 62 pounds nitrogen, of which about two-fifths is water

soluble, 158 pounds phosphoric acid, of which two-thirds is available, and 102 pounds potash.

While the 100 pounds of available phosphoric acid in this formula is about four times the amount removed by the crop, the best experimental evidence indicates that a liberal application of available phosphoric acid is profitable for potatoes. Since phosphoric acid does not leach from the soil, the excess will be available for the following grain and grass crops. Following a crop of potatoes manured as above, usually a good crop of clover could be grown by the use of 200 pounds per acre of a complete fertilizer for a "starter," and 200 pounds of muriate of potash. This last with the phosphoric acid left in the soil would furnish the needed minerals, and the clover would obtain its needed nitrogen from the air.

Nitrate of soda carries about 16 per cent nitrogen, all of which is water soluble. High grade cottonseed meal, carrying 43 per cent of protein, has about 7 per cent nitrogen, 2 per cent phosphoric acid and 1 per cent potash. High grade finely ground bone tankage carries 5 to 6 per cent nitrogen, about one-third of which is water soluble, and about 15 per cent phosphoric acid, one-half of which is available. Muriate or sulphate of potash each carry about 50 per cent potash.

As the result of correspondence on this subject, the writer assisted farmers in Brunswick, Houlton and Fort Fairfield in mixing goods for use with potatoes. The formula used at Brunswick was: Portland Rendering Company's screened tankage 500 pounds; cottonseed meal 200 pounds; nitrate of soda 100 pounds; acid phosphate 400 pounds; and sulphate of potash 200 pounds. This 1,400 pounds of materials carried nitrogen 55 pounds; available phosphoric acid 103 pounds; total phosphoric acid 154 pounds; and potash 103 pounds. The percentage composition as found by analysis was water soluble nitrogen 1.39 per cent; insoluble nitrogen 2.52 per cent; total nitrogen 3.91 per cent; water soluble phosphoric acid 4.51 per cent; citrate soluble phosphoric acid 2.84 per cent, making the available phosphoric acid 7.35 per cent; insoluble phosphoric acid 3.67 per cent and total phosphoric acid 11.02 per cent; and potash 7.38 per cent. This was used by several farmers in Brunswick. The fields were not visited by the writer. Mr. W. S. Morrill,

Brunswick, who was especially interested in having the formula for his own use, wrote relative to the yields as follows: "The yield as compared with last year (1903) was light—on the whole about 50 per cent of that crop. This was due to the season and not the fertilizer. Only one (Mr. Hill) tried the home mixed in comparison with regular ready mixed goods. The difference between the two, while not very marked, was slightly in favor of the home mixed. All that used the formula are perfectly satisfied with their crop, taking all things into consideration, and will surely use the home mixed goods next season."

Mr. J. W. West of Auburn used the home mixture and reports as follows: "It gives me pleasure to reply to your letter of the 19th inst., in regard to the "home mixed fertilizer" compounded by the formula that you published in the Station bulletin last spring.

"I used 500 pounds bone tankage from the Portland Rendering Company, 400 pounds plain phosphate, 200 pounds sulphate of potash, 200 pounds cottonseed meal, and 100 pounds nitrate of soda, thoroughly pulverized and mixed without any carrier. The materials cost at the average rate of about $1.50 per 100 pounds.

"One-half ton of it was used for potatoes on five-eighths of an acre. The soil is a sandy loam, recently cleared and seeded to grass. A portion of the plat was a black loam and rather wet. It was broken up last fall and harrowed thoroughly with a spring tooth and disc harrow. About 500 pounds of the fertilizer were spread broadcast and harrowed in. The ground was then furrowed, and the balance scattered in the hill and mixed with the soil before dropping the seed. This was planted the last of May, using the Green Mountain and Carmen No. 1 varieties. They were sprayed three times with Bordeaux mixture and Paris green. They should have been sprayed once or twice more to kill the bugs which were very plenty, but the press of other work prevented. The vines remained green until the heavy frosts in September. They were dug soon after, yielding 150 bushels full measure (or at the rate of 240 bushels to the acre). There was not over a bushel rotten at the time of digging, but they have rotted some since."

Mr. O. Y. Russell of Danforth used the home mixture and reports as follows. "The formula for potatoes, as I used it, was

100 pounds nitrate of soda, 500 pounds bone tankage, 400 pounds acid phosphate, 200 pounds sulphate of potash, 200 pounds cottonseed meal. I planted four barrels of potatoes, and when I hoed them I estimated that nearly one-third of the seed did not come on account of the wet. I used 1,200 pounds of the mixture on the piece and I got 80 barrels of good ones, and 10 barrels of small ones. I used no barn dressing. I broke up the piece late last fall. It has been down to grass about eight years, and cut about ½ ton to the acre last year. I did not use it in comparison with any other fertilizer, but I think it gave me better results than any other fertilizer I ever used. Several of my neighbors will use it next year."

Several others who used the formula made more or less complete reports to the Station. None of them seemed to have experienced any difficulty in the preparation and application of the home mixed goods. The nearest to a complaint as to the effect of the fertilizer was from a man who called the writer up by telephone at the time of digging and said "the potatoes are so large and the yield so great that the work of digging is greatly increased because of the fertilizer."

These cases are typical of the results obtained outside of Aroostook county. While the formula gave satisfaction, the writer believes that the modifications suggested on pages 140 to 143 of Bulletin 107 would in most instances be found advantageous.

The materials for the home mixed goods used at Houlton and Fort Fairfield were bought at one time and were all mixed at Houlton. The formula was: Portland Rendering Company's (rescreened) tankage 420 pounds; acid phosphate 400 pounds; cottonseed meal 200 pounds; sulphate of potash 200 pounds; and nitrate of soda 100 pounds. Analysis showed the mixed goods to have the following composition: Water soluble nitrogen 1.37 per cent; available nitrogen 2.72 per cent; total nitrogen 4.09 per cent; available phosphoric acid 7.01 per cent; total phosphoric acid 9.87 per cent; and potash 7.61 per cent.

It was designed to apply this at the rate of the 1,320 pounds per acre, but it was actually used quite differently by the different co-operative experimenters. One acre or more was grown upon this formula by John Watson, Houlton, W. S. Blake, Houl-

ton, A. H. Porter, Houlton, E. L. Cleveland, Houlton, R. S. Hoyt, Fort Fairfield, C. A. Powers, Fort Fairfield, F. H. Haines, Fort Fairfield.

The field at Mr. Watson's was planted, grown and harvested under the oversight of the Station. Mr. Powers' and Mr. Hoyt's fields were frequently visited during the growing season and most of the harvesting was under the care of a member of the Station staff. The other fields were, as shown by the yields, well cared for and the data are believed to be accurate. The results at harvest, so far as returns have been obtained, and extracts from the notes taken at different times, follow. Beyond these data, the results are briefly discussed.

At Mr. Watson's, 3 acres were grown upon the home mixed in comparison with the same number of acres grown on Watson's Improved High Grade Potato Manure. The whole formula (1320 pounds per acre) was used, about 1100 at time of planting and the remainder at first cultivation, when the potatoes were breaking through the ground. About the same weight of Watson's Improved High Grade Potato Manure was used, about 1200 pounds at planting and the remainder when the potatoes were breaking through the ground. The potatoes were well cared for during the season. They were sprayed 9 times with Bordeaux mixture, to which at the first 3 sprayings Paris green was added. The field was free from the potato bug, was not damaged by the flea beetle and only slightly by plant lice. There were no signs of blight and no rot at harvest. The whole field was too immature when killed by frost, and the home mixed plots were not as mature as the Watson Improved plots. The comparison would have been fairer if the field had been planted a fortnight earlier, or frost had held off longer. The potatoes on the home mixed plots were all smaller and less matured than on the Watson Improved plots. Each plot contained one acre. The details are given in the table on the top of page 18.

Yields of potatoes grown on home mixed fertilizers compared with a standard potato fertilizer.

	Barrels of Potatoes.		
	Large.	Small.	Total.
Home Mixed Fertilizer.			
Plot 1	109	15	124
Plot 3	101	20	121
Plot 5	112	18	130
Average	107	18	125
Watson's Improved Manure.			
Plot 2	118	15	133
Plot 4	120	15	135
Plot 6	122	17	139
Average	120	16	136

Mr. Blake grew 4 plots upon home mixed and 4 plots upon Watson's Improved. The plots were 1-20 acre in area. On the home mixed the fertilizer was used at the rate of 975 pounds per acre and on the other plots Watson's Improved was used at the rate of 1450 pounds per acre. The field was quite early planted, and the potatoes were well along when frost came. It was sprayed 5 times and was free from blight, and no rot. There were practically no small potatoes.

The yield from the home mixed plots were, per acre, as follows: 102, 107, 107, 109, average 106 barrels per acre. The yield from the Watson's Improved plots were, per acre, as follows: 107, 111, 111, 113, average 110½ barrels per acre.

Mr. Porter grew two acres on home mixed, using it at the rate of 1300 pounds per acre in the midst of a field of 27 acres planted with 1700 to 1800 pounds per acre of Watson's Improved. The rows were 32 inches apart, and the plants 12 inches apart in the row. The land was very uniform, was early planted, well cultivated and kept free from weeds. It was sprayed 6 times. There was no blight and no rot at digging. There were practically no small potatoes. The yield from the 27 acres was 3800 barrels or at the rate of a little over 140 barrels per acre. Mr. Porter did not measure the yield from the home mixed portions, but states that "there was no perceptible difference in appearance or yield."

Mr. Powers at Maple Grove grew several acres on home mixed compared with Darling's Blood, Bone and Potash. The plots alternated. On the home mixed there was used 960 pounds per acre, against 1,000 pounds of Darling's. The yields from the home mixed plots ran from 115 to 123 barrels, with an average of 119. The yields from the two of the plots where Darling's Blood, Bone and Potash were used were 118 and 119 barrels per acre. One plot ran considerably below this, but it was evidently due to the condition of the land. There was practically no difference in the yield with the different fertilizers. The potatoes were quite early planted and while at the first killing frost the home mixed were greener, they were sufficiently matured so as not to materially affect the yield or the appearance of the tubers.

Mr. Hoyt at Maple Grove grew three acres, one each of White Elephant, Dakota Red, and Green Mountain, on home mixed fertilizer in a large field where Crocker's fertilizer was used. The home mixed was applied at the rate of 975 pounds per acre, and the Crocker's at the rate of 1000 pounds. The field was well cared for, including spraying. There was neither blight nor rust. The yields were as follows per acre:

White Elephant	On home mixed, 96 barrels large, 8 barrels small.
	On Crocker's, 100 barrels large and 6 barrels small.
Green Mountain	On home mixed, 118 barrels large, 9 barrels small.
	On Crocker's, 124 barrels large, 10 barrels small.
Dakota Red	On home mixed, 113 barrels large, 3 barrels small.
	On Crocker's, 118 barrels large, and no small.

The potatoes were smaller on the home mixed and the vines were tenderer and were killed by frost earlier than on Crocker's.

CONCLUSIONS.

In general, large crops were obtained on the home mixed goods. On early planted potatoes, and where the season was long enough for the crop grown on the home mixture to mature, the yields were as large as where the standard commercial fertil-

izers were liberally used. The tops kept greener in color during the last half of the growing season with the home mixture. September 1, there was a severe frost all over Northern Maine. The late potatoes grown upon the home mixture had greener and more succulent vines than those upon the standard fertilizers and in consequence were damaged much more by the frost. In fact, the vines of the late planted potatoes on the home mixed goods were practically killed at this time, while the same varieties planted at the same time upon the standard potato fertilizer continued to grow after this frost. As a result, the potatoes were larger and better ripened with these than upon the home mixed plots. For quick maturing, the home mixed goods apparently carried too much slowly available nitrogen and too little available phosphoric acid—a condition that can be readily remedied in a formula. This is discussed on pages 140 to 143 of Bulletin 107 of this Station.

Bulletin 110 containing the results of digestion experiments with sheep and steers, and bulletin 111 containing a reprint of the newspaper bulletins published in 1904, the summary of the meteorological observations for 1904, the report of the treasurer, and the index for the bulletins issued in 1904, are in press and will be sent to the official mailing list of the Office of Experiment Stations and to libraries, without special request. Others desiring copies of these publications can obtain them by applying to the

AGRICULTURAL EXPERIMENT STATION,
Orono, Maine.